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A New Species of *Semiconchula* from Central Chiapas, Mexico (Pulmonata: Xanthonychidae)

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A new species of the genus *Semiconchula* is described. It shares with *Semiconchula custepecana* the internal highly uncalcified shell and two mucus glands, one massive and the second reduced. They differ in the length of the reduced mucus gland and various structures of the reproductive tract. The new *Semiconchula* possesses an asymmetrical central radular tooth in contrast with the symmetrical central tooth of *S. custepecana*. The genus is known only from the state of Chiapas, Mexico.

Resumen

Se describe una nueva especie dentro del genero *Semiconchula*, que comparte la concha interna altamente descalcificada y dos glándulas de mucus, una masiva y la otra reducida. Las diferencias entre las dos especies está en la longitud de varias de las estructuras del aparato reproductor. Con respecto a la rádula, el diente central de la nueva especie de *Semiconchula* es asimétrico en contraste con el diente central simétrico de *S. custepecana*. El género se conoce solamente para el estado de Chiapas, México.

Examination of a semislug specimen recently donated to the California Academy of Sciences Invertebrate Collection and coming from a low mountain close to San Cristobal de las Casas, Chiapas, indicates that it belongs in the genus *Semiconchula*; however, it differs enough in various characters from the one other known species in the genus, which, until recently, was thought to be monotypic, that it must be ascribed to a new species. The type species of the genus *Semiconchula*, *Semiconchula custepecana* Naranjo-García, Polaco, and Pearce 2000, comes from southern Chiapas.

Material and Methods

After dissection of the preserved specimen, the reproductive organs were stained with hematoxylin and eosin, dehydrated with 95% alcohol, changed to absolute ethanol, then to 50% alcohol-toluene, and then four changes in toluene (Miller 1967). Following that procedure, the specimen was mounted in Permount, a synthetic resin. Measurements and the illustration of the reproductive structures were done from the mounted specimen. The drawing was made from the whole mount projected on paper by an overhead projector.

Semiconchula breedlovei Naranjo-García, sp. nov.

Figures 1–3

Diagnosis.— Animal slug-like with a visceral hump on mid-portion of dorsum. Sole undivid-

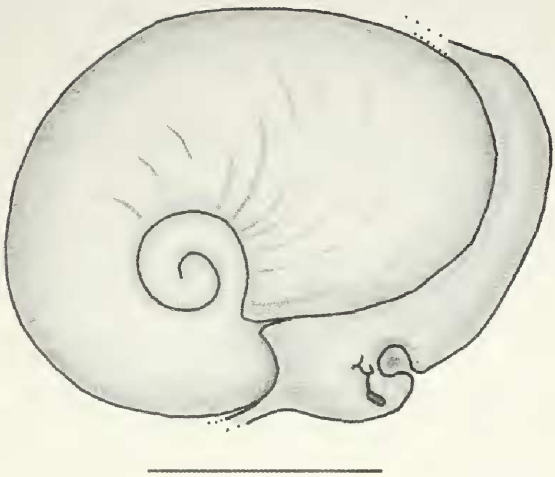

FIGURE 1. Apical view of shell of holotype. Illustration made from dissecting notes after removal of the mantle that entirely cover the shell. On the right side, the mantle collar borders the shell. Scale bar = 5 mm.

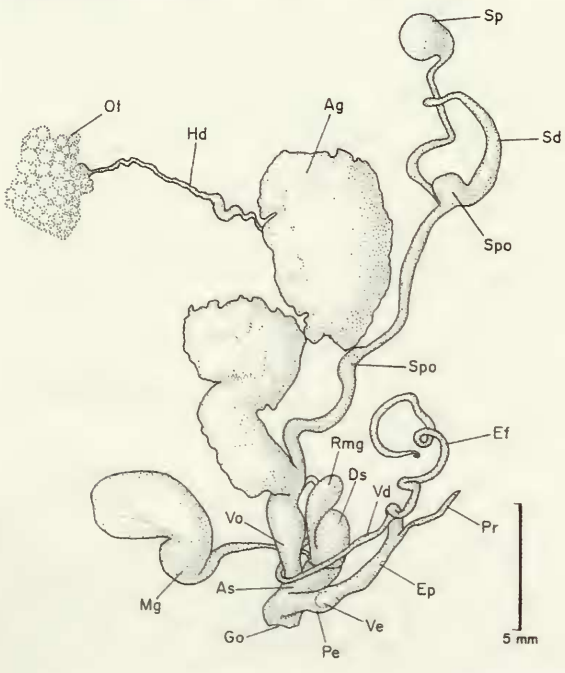

FIGURE 2. Reproductive anatomy of holotype of *Semiconchula breedlovei*, sp. nov.: Ag: Albumen gland, As: Atrial sac, Ds: Dart sac, Ef: Epiphallic flagellum, Ep: Epiphallus, Go: Gonopore, Hd: Hermaphroditic duct, Mg: Mucus gland, Ot: Ovotestis, Pe: Penis, Pr: Penial retractor muscle, Rmg: Reduced mucus gland, Sd: Spermathecal diverticulum, Spo: Spermathecal pouch, Sp: Spermatheca, Va: Vagina, Vd: Vas deferens, Ve: Verge.

ed; foot fringe holopod, without suprapedal groove. On reproductive system penis with verge, flagellum, and spermathecal diverticulum. Dart sac situated high on atrial sac.

DESCRIPTION.— Animal slug-like with visceral hump on the mid-portion of dorsum. Mantle entirely covers the reduced shell.

DESCRIPTION OF SHELL.— Shell vitriniform, internal, depressed, imperforate, delicate, extremely brittle, light brown (Fig. 1). Whorls 2-1/3 expanding rapidly. Apex smooth, body whorl of shell with uneven growth lines. Aperture large, ovate, slightly oblique, wider than high, peristome amber and translucent, soft and thin. Shell covers visceral hump entirely; the nearly uncalcified shell gradually loses more calcium towards the apex and below the hump. At the base of the hump the shell is made of a non-calcified organic sheath. Shell covered entirely by mantle. A strong connective tissue unites shell to collar on left side of body.

MEASUREMENTS OF SHELL.— Maximum diameter 11.0 mm, height 6.3 mm.

REPRODUCTIVE ANATOMY.— Penis short, elongated, cylindrical. Verge short cylindrical, tip broadly conical, slightly less than 1/3 the length of the penis. Penial retractor muscle elongated and attaches on left side of body wall at edge of mantle collar. Epiphallus long and thick, flagellum long and moderately thick originally coiled over itself. Vagina slightly conical, the widest portion apical, length about same as that of penis. Atrial sac cylindrical, wider on the apical portion, inner walls show two muscle dispositions that divide atrial sac in halves. The basal portion with parallel muscles disposed longitudinally, the upper part bearing circular parallel transverse muscles resembling a bellows. Dart sac is an ovate elongated sac situated high on the atrial sac and enters partially into atrial sac (Fig. 2).

There are two mucous glands, one large, the second reduced to about 1/3 the size of the first. The larger mucous gland sacular with inner longitudinal ridges. Second mucous gland a smooth elongated and roundish sac with a narrow inner duct with glandular walls. Each gland has a separate duct opening high in the atrial sac at side of dart sac. Spermathecal duct varies in thickness throughout its length, the inner walls of spermathecal duct with pilasters. It possesses two pouches: one pouch is located approximately half way on spermathecal duct before the fork; the second pouch is located just past the fork that ramifies to the spermathecal diverticulum and the duct that bears the spermatheca itself. Spermathecal diverticulum elongated and of irregular thickness. The spermathecal diverticulum and the first 1/3 portion of spermathecal duct (just after the fork) with glandular walls. Spermathecal diverticulum with a thick, club-shaped structure of about 5 mm, wider basally, inside is one dart, beside this structure two darts. Also, at the basal portion of spermathecal duct another dart is present. In both low and high spermathecal pouches, stiff translucent amber structures of diverse size and thickness are present, perhaps these structures could be remains of darts.

Measurement of reproductive structures (in mm) of holotype.— Penis 1.8, verge 0.5, vagina 1.9, atrial sac 1.8, dart sac 2.3, epiphallus 4.3, epiphallic flagellum 12.7, free oviduct 1.5, spermatheca 1.8, spermathecal duct (to base of diverticulum) 12.3, spermathecal diverticulum 7.5, spermathecal duct from fork to spermatheca 7.5.

External anatomy.— Anterior portion of body brown, flanks light brown-reddish, tail lighter brown than that of head, first pair of tentacles fully contracted (not visible on the surface), second pair of tentacles brown. Mantle, thick, light cream brown (not translucent), with large black raised irregular freckles without a pattern. Body skin irregularly reticulated. Mucus color bright yellow (that fades in alcohol). Tail cylindrical, tapering to the posterior end, tip roundish. A fine mid-dorsal groove runs from edge of hump to tail. No other structures (horn or caudal pore) on tail. Edge of mantle on left side of body outlined by a fine pigment accumulation. Pneumostome and anal pore are on anterior, right lower edge of visceral hump. The respiratory pore located on the upper and anal pore on the lower portion. Pneumostome with a roundish upper lappet limiting the respiratory pore and overhanging at both anterior and posterior ends. The anal pore is an oblique, semi-lunate slit with edges pointing upwards. The lappet's external wall overhangs the body and is fused with the mantle on the posterior side. Gonopore ovate, whitish and with smooth edge.

Radula and jaw of holotype.— Radular teeth tricuspid; central tooth asymmetrical with the middle cusp wide, left cusp situated low, right cusp wide with the outer edge of base thickened and rounded (Figs. 3A–B). Central cusp widest and tallest in lateral teeth. In teeth 21 to 30, the inner lateral cusp is almost of the same size as central cusp (Figs. 3C–D). In tooth 31 the central and inner lateral cusps are less pronounced. In teeth 32 to 35 the central and inner lateral cusps gradually reduce in height. In tooth 36 all three cusps are about same height, the central and inner cusps remaining slightly closer together. Tooth 37 with four cusps, two tall inner and two short outer cusps. Tooth 38 roundish (Figs. 3C, E). Jaw arched with two mid-lateral ribs extending beyond the margin of the jaw (Fig. 3F). Tooth formula 36-1-36 to 38-1-38 (Fig. 3B).

Internal anatomy.— Right ocular retractor muscle (RER) almost dorsal, slightly to the right of the mid-longitudinal line. It (RER) passes over the vagina and joins the columellar muscle passing between the reproductive organs and esophagus. The esophagus and penis are pushed to the left side of body. Reproductive organs occupy most of the anterior body cavity. The diaphragm is located below the reproductive organs (ovotestis, hermaphroditic duct and spermatheca). The columellar muscle, well developed, runs from anterior portion of foot, over the stomach, below prostate-uterus, then crosses the diaphragm and attaches to the weak shell passing between the digestive gland and ovotestis. Salivary glands flat, long and of irregular shape and appressed to the esopha-

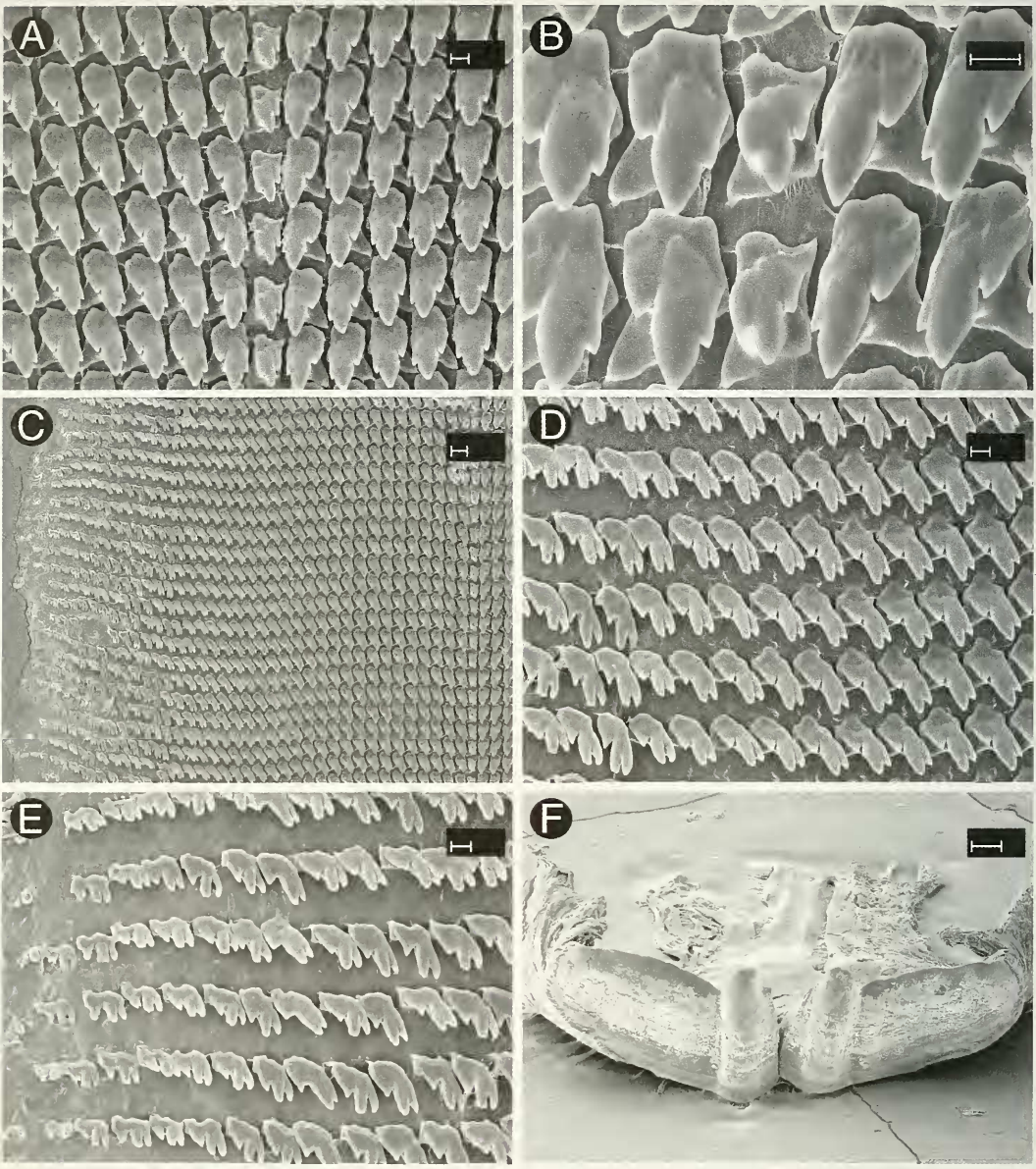

FIGURE 3. Preparation of radula and scanning electron microscope (SEM) photographs by Yolanda Camacho-García. (A) central tooth and lateral teeth 1 to 6, from central tooth to the left, scale bar =10μm. (B) central tooth close up, in middle row, scale bar =10μm. (C) general view of radula from central tooth (right hand side to the left) to marginal teeth, scale bar =30μm. (D)teeth 16 to 26 from right to left, scale bar =10μm. (E) teeth 27 to 36 from right to left, tooth formula 36-1-36 to 38-1-38, scale bar =10μm. (F) jaw of *Semiconchula breedlovei* is shown in upside down position in reference with its location on the snail body. It also should be noted that jaw broke in the mid-line during processing, scale bar =100μm.

gus and stomach. The right gland appressed to the right side, length over 7 mm. The left salivary gland is appressed to the bottom of the esophagus and stomach, length about 10 mm. The lung is on the right anterior side of visceral hump. The kidney is above it. Lung and kidney are spongy.

TYPE LOCALITY.— MEXICO, Chiapas. W of San Cristobal de Las Casas, steep, heavily wood-

ed slope with *Quercus* and *Drimys* near the summit of Muk'ta vits (Cerro Huitepec). The dominant species was *Lamourouxia stenoglossa* F.W. Hunnewell and L.B. Smith from the family Scrophulariaceae. Elev. 2600 m., 25 September 1976. Collector Dennis E. Breedlove.

Material examined. — Holotype: California Academy of Science, Invertebrate Collection, CASIZ 077540. Paratype: Same locality as holotype, 22 October 2002, Collector Gerardo Carbot-Chanona. Colección Nacional de Moluscos, Instituto de Biología, U.N.A.M. CNMO 1203.

Habitat.— Most of the vegetation of Cerro Huitepec is a secondary oak forest and is a reserve under the care of the group Pronatura, except for the summit that has some very reduced patches of original vegetation. According to Breedlove (1981), most of the original vegetation in the Chiapas Plateau has disappeared due to the type of agriculture employed by the Mayan farmers, who have used all the available land for cultivation.

Etymology.— The species is name after Dr. Dennis E. Breedlove, who collected non-marine mollusks during his botanical explorations in Chiapas.

Remarks.— The paratype presents the same general external characters as the holotype, except for the darker body and reddish color. The shell of the paratype is smaller, with maximum diameter measuring 7.8 mm and height 3.0 mm, two whorls and a sculpture of fine growth lines. The specimen is sub-adult showing the reproductive organs in early stage of development.

Discussion

Semiconchula breedlovei is most closely related to *Semiconchula custepecana* (Naranjo-García, Polaco, and Pearce 2000) from the same state (Chiapas) but separated by a straight line distance of 100 km and the central depression (central depression physiographic region according to Müllerried 1957). The two species share the internal, vitriniform, depressed, imperforate, thin, fragile shell. They both possess a short penis, epiphallic flagellum and spermathecal diverticulum, single dart sac, and the two mucus glands, and both have one mucus gland massive and the other reduced. They also share the highly vascularized (spongy) lung. Nonetheless, they differ in that the delicate radial ribs of the embryonic shell of *Semiconchula custepecana* are not present in *Semiconchula breedlovei*. In *S. breedlovei* the shell is more fragile than in *S. custepecana*. They also differ in the length of the penis, the verge and the vagina, all structures being slightly larger in *S. custepecana*. The second reduced mucus gland in *S. custepecana* is a rounded vesicle while in *S. breedlovei* is an elongated roundish sac, 9 times larger. Both species share the inner circular muscles that resemble a bellows on the atrial sac; however, they differ on the basal portion of the atrial sac with parallel longitudinally disposed muscles present in *Semiconchula breedlovei* but not in *S. custepecana*.

Other differences are in the epiphallus, epiphallic flagellum, and the spermathecal duct, which are 2.7, 2.4 and 2.3 times longer, respectively, in *S. breedlovei* than in *S. custepecana*. Debris and the presence of darts inside the spermathecal duct and spermathecal pouches suggest that in *Semiconchula breedlovei* the spermatheca is also a digestive and reabsortion organ, as has been shown for *Biomphalaria glabrata* (Kitajima and Paraense 1983; Roger and Reeder 1987) and for five species of *Sonorella* (Reeder and Rogers 1979; Rogers Reeder and Shannon 1980).

The tooth formula differs between the two species; being 32-1-32 to 36-1-36 in *S. custepecana* and 36-1-36 to 38-1-38 in *S. breedlovei*. The central tooth is symmetrical in *S. custepecana* in contrast to the asymmetrical one in *S. breedlovei*. The marginal teeth are also dissimilar. Tooth 32 in *S. breedlovei* is robust with three well defined cusps, in contrast to tooth 32 in *S. custepecana*, which is small, with reduced cusps, almost obsolete.

On 19 August 1991, we (Oscar J. Polaco, three of his students, and the author) attempted to

find more specimens of this new species of *Semiconchula*. However, our efforts were fruitless due to the highly modified environment at Cerro Huitepec (on one side). We were informed that the other side of the mountain possessed a more natural forest but, unfortunately, that side was (and continues to be) under the surveillance of the guerrillas, and it was not advisable to approach it. Efforts to obtain more specimens were started again by local biologists in July 2002. Fortunately, following Dr. Breedlove's directions, Gerardo Carbot-Chanona and I were able to find **a** second specimen on 22 October 2002. At this time, we again recorded the small size and patchiness of the habitat where this new species lives. *Semiconchula breedlovei* is an endangered species according to the IUCN criteria (1996) because of the highly modified habitat at Cerro Huitepec.

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